



Food loss analysis: causes and solutions

Mango supply chain in India

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Mango (*Mangifera indica L.*) is an important fruit because of the income derived from the crop and also for its nutritive value and health-promoting properties. The fruit provides energy and is a good source of carbohydrates, fibre, minerals and vitamins. India is the world's leading producer of mango where it is cultivated in 2.2 million hectares with a production volume of 19.57 million tonnes. The industry is largely operated by 76 percent smallholder and marginal farmers contributing 30 to 40 percent to their income. Inefficiencies and failure in the supply chain lead to post-harvest losses and consequently to reduced profitability.

of the latter. At the farm, harvesting including sorting results in quantitative loss of 12 percent and 20 percent for the processed and fresh fruits, respectively (Table 1) mainly in the form of cracked fruit due to faulty harvesting. Qualitative loss amounts is a CLP in the fresh fruit chain only and amounts to 15 percent quantitative loss and 20 percent qualitative loss. For the processed fruit chain, the traditional method of ripening is a CLP with quantitative loss of 19.75 percent and 20 percent qualitative loss due to decay and uneven fruit ripening. Ripening is not a CLP in the fresh fruit chain. Retailing is a CLP for the fresh fruit chain where all the inefficiencies in the earlier part of the chain become apparent in the form of decay, mechanical damage, and fruit shriveling due to moisture loss.

The mango supply chain

Two supply chains were assessed in Andhra Pradesh specifically in the districts of Vizianagaram for the fresh fruit, and Chittoor for the processed (pulp). Observations, direct interaction with the stakeholders and actual load tracking were done to provide an estimate of the quantitative and qualitative losses and identify the critical loss points in the chain.

Mango production is dominated by smallholder farmers who either manage their own farms or lease them to pre-harvest contractors who perform all the farming activities. Farmers harvest and arbitrarily sort the fruits and pack in cartons at the farm. Farmers ei-

ther sell directly to wholesalers in the market yards or collection centres or to the assemblers. From the collection centres, mangoes are transported either to the wholesale markets (fresh fruit) or the exporter's packhouse or to the processing plant. The retailers and the consumers are the last stakeholders in the chain who bears the losses along the chain (Table 1).

Critical loss points in the supply chain

The critical loss points (CLP) in the chain are similar for both the fresh and processed except for the ripening operation in the case

Impact of post-harvest losses

The losses incurred at different steps in the supply chain have a direct impact to the smallholder farmers wherein 30 to 40 percent of their income comes from mango farming. For the other stakeholders in the chain like the wholesalers and retailers, their

TABLE 1
The mango supply chain, stakeholders, operations and loss points

Supply chain level	Production →	Collection centre →	Wholesale market Export Processing plant →	Retail market Domestic Export →	Consumption
Stakeholders	Farmer Contractor	Assembler Commission Agent Transporter	Wholesalers Exporter Processor	Retailers	Consumers
Operations	Harvesting Sorting Packaging	Packaging Transport	Ripening (processing)	Retailing	Buying Consumption
Losses (%)					
Quantitative:					
Fresh	20	15	N/A	5.1	
Processing	12	0.5	19.75	N/A	
Qualitative:					
Fresh	5	20	N/A	25	
Processing	5	<1	20 (traditional) 3-6 (ripening chamber)	N/A	

TABLE 2
Budget calculation for the use of plastic crates

Item	Value/Unit
Product quantity	183 828.4 tonnes/yr
Product value	210 USD/tonne
Loss rate	15%
Food loss	79 925.4 tonnes/yr
Economic loss	16 784.334 USD/yr
Total cost of intervention	2 856.305 USD/yr
Client cost of intervention*	5 3606 USD/tonne
Anticipated loss reduction	20%
Volume of loss reduction	15 985.08 tonnes/yr
Loss reduction savings	3 356 867 USD/yr
Profitability of the intervention	500 562 USD/yr

*Only 50% cost of plastic crate since it will be used for other Crops +depreciation cost + cost of transporting crates

income from mango depends on the volume traded. On-farm losses and those incurred after harvest mean loss opportunity for sale. In the case of the processors, post-harvest losses mean reduced volume for processing and/or inferior quality of processed product. Besides outright loss in marketable volume, qualitative losses result in low-priced produce and the hidden loss in nutritional value of low quality produce.

The importance of good post-harvest handling practices

The quality and potential shelf life of the mango fruit is established at harvest. Harvesting at immature stage will result in either failure to ripen or uneven ripening with poor flavour and aroma. Faulty harvesting results in fruit cracks that are unmarketable. Mango fruits are highly perishable. They are harvested at the green mature stage and ripen within 4 to 5 days under ambient condition. As the mango starts to ripen, its resistance to compressive damage weakens hence the high incidence of damage when packed in recycled cartons that are stacked several layers high during transport. The onset of ripening also marks the development of decay which becomes more apparent at the wholesale and retail levels. Good practices during harvesting and subsequent operations along the chain will minimize losses in the mango supply chain resulting in increased benefits to the stakeholders.

Recommendations to reduce losses and their economic benefits

Losses occur because of technical and extra-technical reasons. Technical causes like faulty harvesting, poor packaging and improper ripening conditions can be controlled by employing technologies. On the other hand, extra-technical causes which in some cases far outweigh the technical ones are those that cannot be solved by technologies as in the case of weak infrastructure and lack of awareness of the stakeholders that losses can be minimized.

A technical intervention to reduce losses in the form of mechanical damage during long-distance transport is the use of plastic crate as transport container (Figure 1). Plastic crates are rigid insuring adequate protection to their contents, stackable and returnable. Plastic crates also provide adequate ventilation thus retarding the ripening of mangoes while in transit and consequently the onset of decay thus the extended shelf life of mangoes in retail market. Plastic crates can be washed thus preventing cross-contamination unlike when recycled cartons are used. Since the initial investment of plastic crates is high and may not be affordable to farmers and traders, the government or the private sector can buy the crates and rent these to the users. The transporters likewise can provide the plastic crates for a fee. Assuming that 50 percent of the production in Vizianagarm is destined for distant markets which is equivalent to

TABLE 3
Budget calculation for on-farm training

Item	Value/Unit
Product quantity	532 836 tonnes/yr
Product value	210 USD/tonne
Loss rate	10%
Food loss	53 283.6 tonnes/yr
Economic loss	11 189 556 USD/yr
Total cost of intervention	27 800 USD/yr
Client cost of intervention*	0.0522 USD/tonne
Anticipated loss reduction	30%
Volume of loss reduction	15 985.08 tonnes/yr
Loss reduction savings	3 356 867 USD/yr
Profitability of the intervention	3 329 066.8 USD/yr

183 828 tonnes per year and a loss rate of 15 percent with traditional packaging, food loss is 79 925 tonnes per year and an economic loss of USD 16 784 334 per year (Table 2). With the use of plastic crates on a rental basis and with the anticipated loss reduction of 20 percent equivalent to 15,985.08 tonnes per year, the loss reduction savings will be USD 3 356 867 per year. The profitability of using plastic crates amounts to USD 500 562 per year.

Another intervention to reduce losses due to extra-technical factor is capability building of stakeholders on good post-harvest management. On-farm training and pilot demonstration of good handling practices versus the traditional wherein stakeholders can quantify the benefits. Training should be done at the start or during the harvest season. Training materials in the native language will enhance awareness on good post-harvest management. Table 3 shows the profitability of on-farm training as a means of reducing losses.



FIGURE 1
Plastic crates as transport container

This information sheet summarizes the results of the study on Food Loss Analysis: Causes and Solutions, Case Studies in Small-scale Agriculture and Fisheries Subsectors of the Food and Agriculture Organization (FAO) of the United Nations. For more information: Global Initiative on Food Loss and Waste Reduction (www.fao.org/save-food).



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